

Acknowledgements

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[Editor's Note: Congratulations to high school students Montminy and McDonald on their work and a salute to their mentor Durkee for guiding them.]

NEGLECTED LIGHTCURVES FROM THE SHED OF SCIENCE

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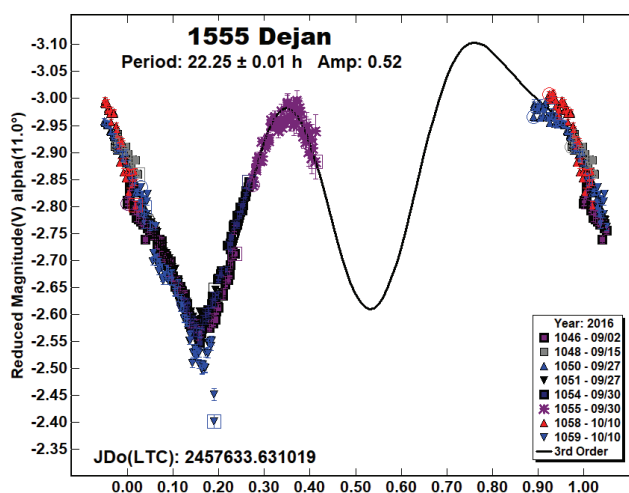
(Received: 2018 Jun 16)

CCD observations of five asteroids made between 2016 July and November led to finding synodic periods and lightcurve amplitudes for 1555 Dejan ($P = 22.25 \pm 0.01$ h, $A = 0.52 \pm 0.05$ mag), 4488 Tokitada ($P = 34.25 \pm 2.25$ h, $A = 0.58 \pm 0.07$ mag), 5996 Julioangel ($P = 9.74 \pm 0.01$ h, $A = 0.34 \pm 0.07$ mag), 8083 Mayeda ($P = 11.75 \pm 0.05$ h, $A = 0.76 \pm 0.05$ mag), and (20447) 1999 JR85 ($P = 4.925 \pm 0.015$ h, $A = 0.24 \pm 0.05$ mag).

CCD photometry observations of five asteroids were made at the Shed of Science Observatory between 2016 July and November. The observations used a 0.5-m Planewave corrected Dall-Kirkham telescope with a focal reducer, which gave a focal ratio of $f/5.3$ and plate scale of 1.24 arcsec/pixel. An SBIG ST-10XME CCD camera and Celestron UHC LPR filter were used for all exposures.

All images were dark and flat-field corrected and then measured using *MPO Canopus* (Bdw Publishing) with a differential photometry technique and its Comp Star Selector to link sessions. The data were light-time corrected. Period analysis was also done with *MPO Canopus*, which incorporates the Fourier analysis algorithm (FALC) developed by Harris (Harris et al., 1989).

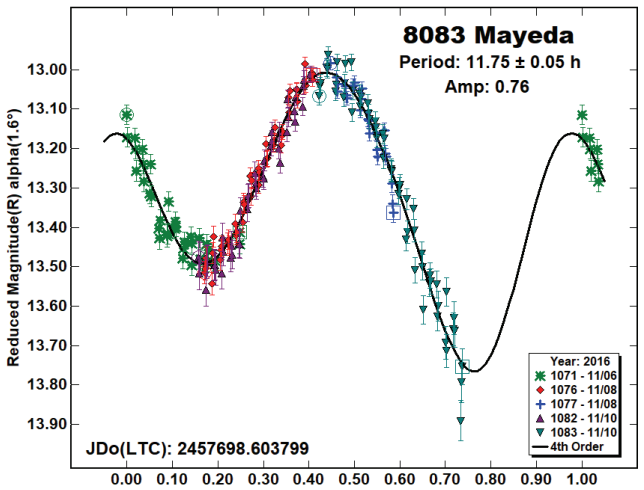
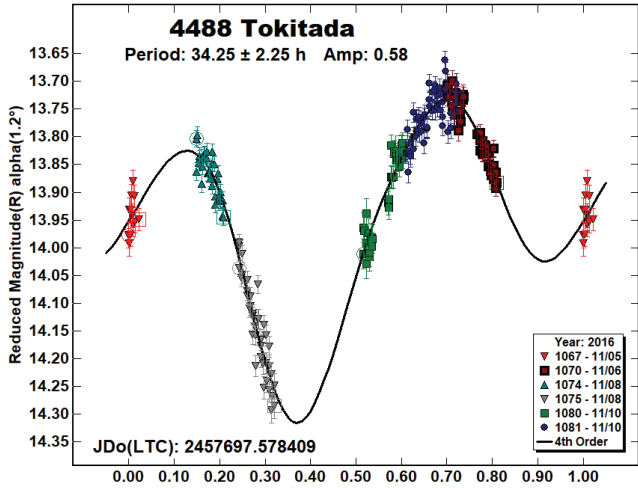
1555 Dejan. Analysis of observations over five nights between 2016 Sep 2 and Oct 10 indicates $P = 22.25 \pm 0.01$ h, $A = 0.52 \pm 0.05$ mag. Earlier observations indicated a period of 16.960 $\pm$ 0.002 h (Brines et al., 2017). However, our data do not support their period near 17 hours but instead the longer period near 22 h.



Number	Name	2016/mm/dd	Phase	L _{PAB}	B _{PAB}	Period(h)	P.E.	Amp	A.E.	Grp
1555	Dejan	09/02-10/10	8.1, 3.5, 14.7	352	5	22.25	0.01	0.52	0.05	MB-M
4488	Tokitada	11/05-11/10	1.0, 4.3	41	-1	24.25	2.25	0.58	0.07	FLOR
5996	Julioangel	09/02-10/10	11.1, 7.9, 13.0	356	15	9.74	0.01	0.34	0.07	EUN
8083	Mayeda	11/06-11/10	0.9, 3.6	41	0	11.75	0.05	0.76	0.05	MB-O
20447	1999 JR85	07/31-08/04	13.6, 14.3	303	17	4.925	0.015	0.24	0.05	MB-M

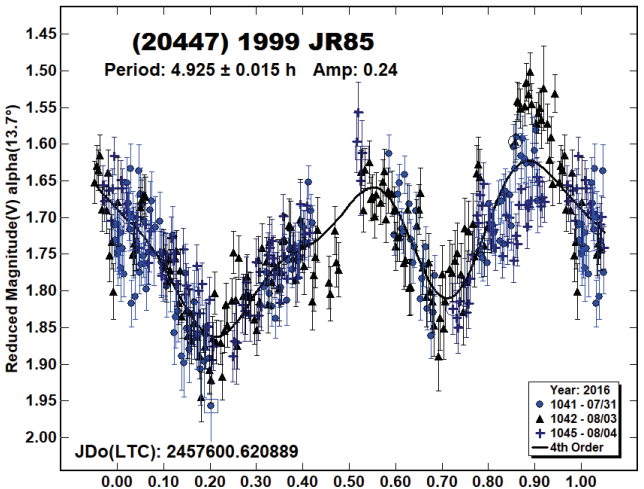
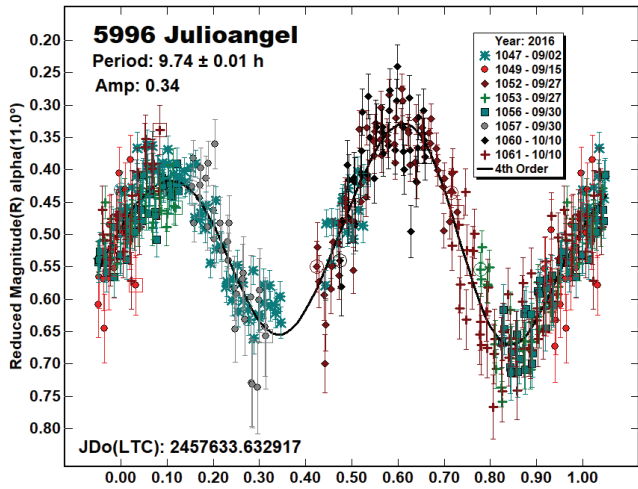
Table II. Observing circumstances and results. The phase angle (α) is given at the start and end of each date range. If three values are given, the phase angle reached a minimum. L_{PAB} and B_{PAB} are, respectively, the average phase angle bisector longitude and latitude (see Harris *et al.*, 1984). The Group column gives the orbital group to which the asteroid belongs. The definitions are those used in the LCDB (Warner *et al.*, 2009). MB-M/O: Main-belt middle/outer; FLOR: Flora; EUN: Eunomia.

4488 Tokitada. Observations were made over four nights between 2016 Nov 5-10. Data analysis found a synodic period of $P = 34.25 \pm 2.25$ h, $A = 0.58 \pm 0.07$ mag.



(20447) 1999 JR85. Observations over three nights between 2016 Jul 31 and Aug 4 led to a synodic period of $P = 4.925 \pm 0.015$ h, $A = 0.24 \pm 0.05$ mag.

5996 Julioangel. Data obtained over five nights between 2016 Sep 2 and Oct 10, led to a synodic period of $P = 9.74 \pm 0.01$ h, $A = 0.34 \pm 0.07$ mag.



8083 Mayeda. Analysis of our data, obtained over three nights between 2016 Nov 6-10 indicates a synodic period of $P = 11.75 \pm 0.05$ h, $A = 0.76 \pm 0.05$ mag.

Acknowledgements

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A PHOTOMETRIC STUDY OF 1144 ODA

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Minor planet 1144 Oda is a tumbling asteroid with periods probably near 648 hours and 553 hours, maximum amplitude 0.55 ± 0.05 magnitudes

Minor planet 1144 Oda, $a = 3.754$ AU, $e = 0.096$, $i = 9.74^\circ$, is the only large diameter asteroid ($D \sim 55$ km) with an orbit lying between the outer edge of the Cybele zone near 3.65 AU and the inner edge of the Hilda 3:2 Jupiter resonators near 3.88 AU.

Previously published rotation periods for 1144 Oda are 14.4 hours from a very sparse lightcurve (Behrend, 2006) and by Waszczak et al. (2015) who made 1 to 4 measurements on each of 11 nights from 2011 May 11 through June 20 for a total of 26 data points to derive a period of 44.023 hours and amplitude 0.41 magnitudes.

A more comprehensive survey was made at the Organ Mesa Observatory with a 0.35-meter Meade LX200 GPS Schmidt-Cassegrain (SCT) and SBIG STL-1001E CCD. Exposures were 120 seconds, unguided, with a clear filter. All measurements were calibrated from CMC15 Sloan r' values converted to Cousins R magnitudes using $R = r' - 0.22$ for solar-colored field stars. Photometric measurement was with *MPO Canopus* software.

Sixty sessions were obtained from 2018 Feb 8 through May 21. A raw lightcurve prepared by *MPO Canopus* including data from all sessions features a quasi-periodic variation with the usual two maxima and minima per cycle in a period near 615 hours, but with an amplitude varying from near zero to a maximum of about 0.55 magnitudes. To reduce the number of points on this lightcurve and make it easier to read, data points have been binned in sets of 3 with a maximum time difference of 6 minutes between points in each bin.

The author thanks Petr Pravec (personal communication) for the application of simultaneous dual-period software to the complete data set. Tumbling behavior is confirmed. However, a period solution is not very clear. The most likely periods may be about 648 and 553 hours, but other values are also possible. It is not determined which period is rotation and which is precession. There are also signals for periods around 51.8 and 44.1 h, but they appear to be aliases with Earth rotation: Note that $1/51.8 = 1/48 - 1/648$ and $1/44.1 = 1/48 + 1/553$. A lightcurve phased to 648 hours with the dual period software illustrates very different successive cycles.

The raw lightcurve is analogous to beat phenomena of two acoustic signals of slightly unequal frequency or period, in which the tumbling periods of 553 hours and 648 hours combine for an

Number	Name	2018/mm/dd	Pts	Phase	LPAB	BPAB	Period(h)	P.E	Amp	A.E.
1144	Oda	02/08-05/21	3979	9.9, 1.2, 13.2	179	5	648 553	10	0.55	0.05
	P2									

Table I. Observing circumstances and results. Pts is the number of data points. The phase angle is given for the first date, minimum value, and last date. LPAB and BPAB are the approximate phase angle bisector longitude and latitude at mid-date range (see Harris *et al.*, 1984). P2 is the second period of tumbling.